Fano and Andreev Reflection in Quantum dots

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Abstract

Quantum dots are nano-devices in which electrons are confined in all space dimensions [1]. As a consequence of this confinement energy and charge are quantized. Because of both features are present in real atomic systems, useful analogies between and atomic systems have been exploited recently. By enforcing this analogy, effects like Fano effect [2,3] have been also found to be present in quantum dot configurations. The Fano effect originally arises when quantum interference takes place between two competing optical pathways, a discrete auto-ionized state with a continuum, giving rise to characteristically asymmetric line-shapes [2]. Unlike the conventional Fano resonance, the Fano effect in the quantum dot system has its advantage in that its parameters can be tuned continuously [3].

Recently, it has been much interest in the normal metal-superconductor junctions. These hybrid systems are very interesting for the so-called Andreev reflection (AR). In AR process an incident electron from the normal metal is reflected as a hole while a Cooper pair is created in the superconductor [4]. In these systems the superconductor acts as a source of spin for spintronics.

In the present work, we investigate the transport properties of a T-shape double quantum dot coupling to a superconductor lead and two normal leads. (Fig. 1) We found Fano-line shapes in the normal-normal quantum mechanics transmission due to Andreev reflection in the superconductor lead. This effect is studied as a function of the parameters defining the system.

References

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Figures

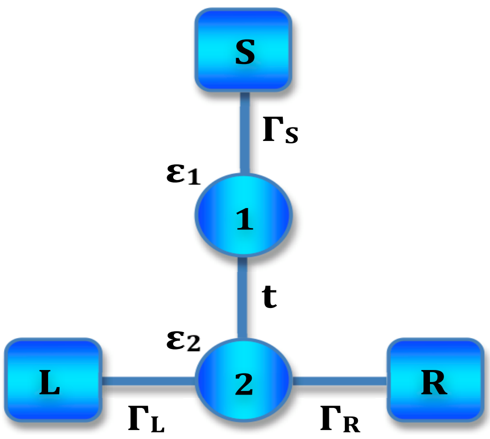

Fig 1. Schematic view of T-shape double QD system coupled to left (L) and right (R) normal leads and a superconductor lead (S) with an inter-dot coupling denoted by t.

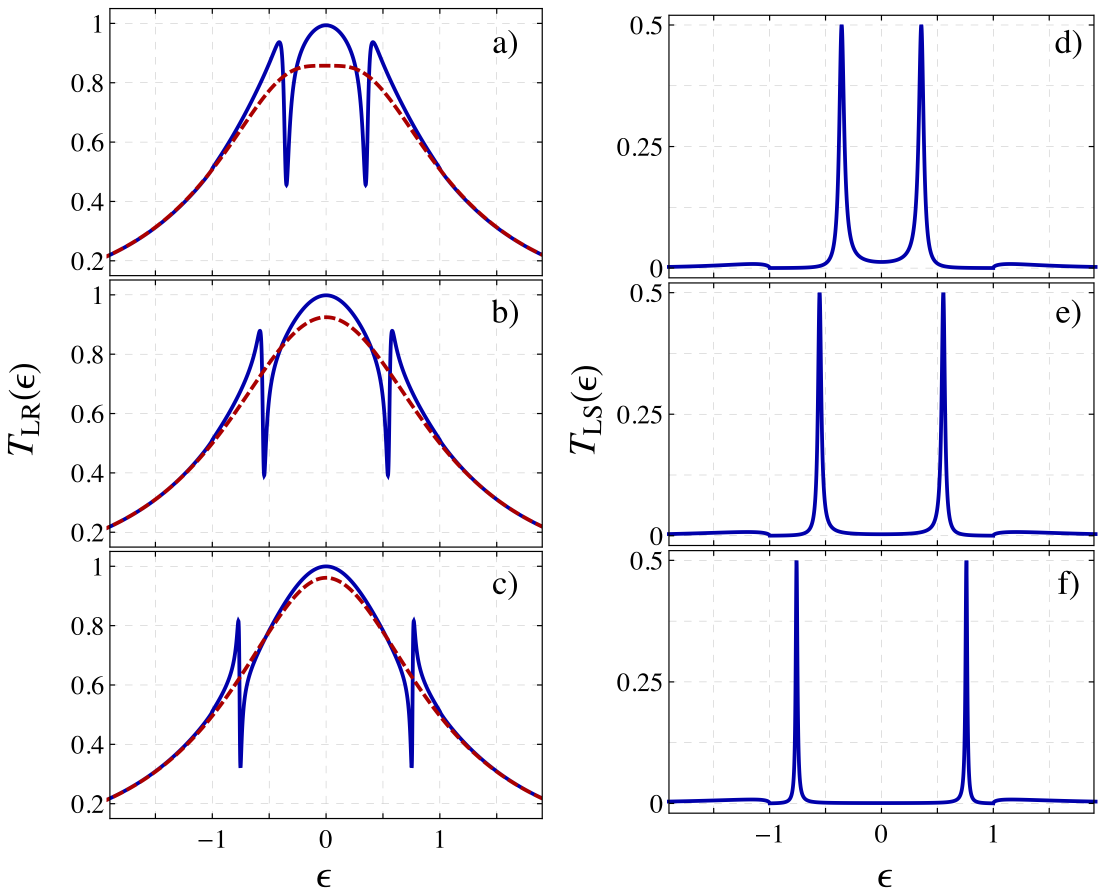

Fig 2. Transmission from left to right lead (left panel) and from left to superconductor lead (right panel) versus energy for a T-shape DQD with parameters: $\Delta=\Gamma_L$, $\Gamma_R=\Gamma_L$, $\varepsilon_1 = \varepsilon_2 = 0$, $t=0.2\Gamma_L$ a) $\Gamma_S = \Gamma_L$, b) $\Gamma_S = 2\Gamma_L$ and c) $\Gamma_S = 4\Gamma_L$ Dashed line in left panel correspond to transmission with $\Delta=0$, i.e for a system with three normal leads. (Δ superconductor gap)